ATTACHMENT A

Substitute Specification

DESKTOP PROJECTION MONITOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims an invention which was disclosed in Provisional Application Number 60/108,100, filed November 12, 1998, entitled "Desktop Projector". The benefit under 35 USC §119(c) of the United States provisional application is hereby claimed.. This application is also a continuation-in-part of Serial No. 09/323,651, filed June 1, 1999, which is also a PCT International Application No. PCT/US99/26784, filed November 30, 2000. The above priority applications are hereby incorporated herein by reference.

FIELD OF THE INVENTION

The invention pertains to the field of display devices. More particularly, the invention pertains to video displays for computers using projection technology. The invention also pertains to a methodology and system design of eyestrain reduction for personal displays.

BACKGROUND OF THE INVENTION

Dr. Steven Sauter has studied extensively the health effects of Video Display Terminals ("VDTs", also referred to as "cathode-ray tubes" or "CRTs", and generally as computer monitors) and describes the common problem of eyestrain :

> As a class, visual system disturbances such as sore, aching, irritated, or tired eyes, and blurred or double vision are probably the most common health-related complaints among VDT users. Headache is often included in this cluster. Together, these types of disturbances are often referred to loosely as asthenopia, visual fatigue, or simply eyestrain... "Occupational Health Aspects of Work With Video Display Terminals", from Environmental and Occupational Medicine, pp1109-1119, William N. Rom, ed., Boston: Little, Brown, 1992, ISBN 0316755672.

A 1991 poll of office workers by the Louis Harris Organization (*Journal of Behavioral Optometry*, Vol. 5, No. 3 (1994), p. 59) reported that computer eyestrain was the number one job-related complaint in the work force of the United States.

A Cathode Ray Tube creates images by shooting an electron gun at wall of phosphors elements aligned as a grid, each representing a pixel. When hit by electrons, these elements emit photons directly at the user. There is a direct transmission of light from the phosphor elements, where the light is generated, to the user's eyes. "Direct transmission" is defined as light traveling in a path without reflection. From the 2-dimensional phosphor grid, the photons collectively produce an image as the gun sweeps from left to right and top to bottom in a process called raster scanning. The screen is usually redrawn, or refreshed, 60 or more times in a second. A fundamental aspect of the CRT technology is the direct transmission of the image over a short distance, the principal cause of eyestrain and headaches as described below with the Computer Eyestrain Theory.

The Computer Eyestrain Theory, developed by the present inventor, explains that directly transmitted light over a short distance adversely affects the human visual system. According to the theory, the solution is in using reflected light, rather than directly transmitted light, and elongating the distance traveled by the light, to principally alleviate eyestrain, assuming all other environmental and physical factors are held constant, at a typical level. The lighting in the computer office environment, work associated stress level of the computer user are each important factors that influence eyestrain.

The Computer Eyestrain Theory states that eyestrain derived from the use of computers is principally alleviated upon the application of these two principles: when the length of the distance from the (multi-point) light source used to create the image to the viewer's eyes is increased; and when the occurrence of at least one reflection in the path of the image is created. Both the reflection and distance contribute to creating a more random and uniform distribution of light before reaching the human visual system. Several point sources in close proximity can serve as a first order model for all monitors, where each pixel acts as an independent point source.

In the natural world of the human visual system, light that is absorbed has a definite random and uniform property partly due to diffuse reflection. Human beings typically don't look straight at the Sun but rather view objects using the Sun's reflection. The light

has traveled a long distance and has experienced reflection before reaching a human visual system. The human visual system is designed to handle this type of light that is more random or more uniform. Using the multi-point light source as the model, a direct transmission monitor emits light with less uniformity because each independent point source emits photons over a short distance from the monitor to the viewer, with no reflection in the path. A CRT monitor with a SXGA (1280X1024) resolution has over one million independent light sources emitting photons to the eyes.

According to the theory, the human visual system has a much harder time coping with directly transmitted light over a short distance, especially for extended periods of time. Those with impaired visual systems are the ones most likely to experience more eyestrain in a shorter time span.

Assuming that the viewer is at a fixed distance close to the monitor, the Computer Eyestrain Theory postulates that the most important factor in alleviating eyestrain is to create a reflection in the path of the image, rather than the type of light source used. It is not the type of light emitted which causes eyestrain such as metal halide lamps, light-emitting phosphor pixel elements or other types. For example, experiments were conducted with a CRT monitor, as the source of the image emitting photons with its phosphor pixel elements. Using two mirrors to get the correct inversion, there was eyestrain **without** the mirrors and no eyestrain **with** the mirrors supporting the Computer Eyestrain Theory. In both cases, phosphor elements acting as the type of light used did not change. The inventor tested three different types of projector technologies each with their own light source with no eyestrain. Additionally, the inventor tested three different types of direct transmission monitors each with their unique light source and experienced eyestrain.

Creating a reflection in the path of the image is one of the principles of the Computer Eyestrain Theory to principally alleviate eyestrain. Experiments have shown that specularly-reflecting surfaces such as aluminum or glass mirrors, and diffusely-reflective surfaces, such as conventional projection screens are both effective in helping to alleviate eyestrain (though of course allowance must be made for the fact that a specularly-

reflecting surface inverts the image, unlike a diffusely-reflecting surface). It is difficult to achieve a pure specularly-reflecting surface for any purpose. One should assume that there are some diffusive characteristics on any experimented reflecting surface on some magnification level. Therefore, reflection is important because it contributes to creating a type of light that is more random and uniform.

A direct consequence of these experiments conducted on the light source and reflecting surfaces is that the alleviation of eyestrain is independent of the projection technology. Experiments have been conducted on various projection technologies from LCD (Liquid Crystal Display) and DMD™ (Digital Micromirror Devices™) to Film projectors reaching the same conclusion that a projection system alleviates eyestrain compared to all direct transmission technologies, examples of which include CRT (Cathode Ray Tube) monitors, LCD monitors, PDP (Plasma Display Panel) monitors, PALCD (Plasma Addressed Liquid Crystal Display) monitors, and FED (Field Emissive Display) monitors. The theory has only one requirement to successfully alleviate eyestrain at a roughly close fixed distance, the image has to be reflected before reaching the viewer.

Thus, according to the theory, direct transmission of the image from a conventional CRT monitor to the viewer over a short distance causes most of the eyestrain. There may be other contributing factors such as the lighting at the location of the monitor, radiation, and the level of stress attributed to the work. However, keeping other environmental and physical factors constant, at a typical level, according to the theory, the principal cause of eyestrain is directly transmitted light over a short distance.. In particular, one experiment was conducted with a CRT monitor, as the source of the image, using two mirrors to get the correct inversion. There was eyestrain **without** the mirrors and no eyestrain **with** the mirrors. This supports the Computer Eyestrain Theory because in the experiment with the mirrors the image has traveled a longer distance to the eyes and experienced reflection.

In the eye medical community, it is commonly accepted that a larger image at a further distance is easier on the eyes, contributing to the alleviation of eyestrain occasioned by the use of computers. This distance from the eyes to the image is referred to as the focusing distance or optical distance. According to this line of thinking, if the image is being

reflected, then the focusing or optical distance is only to the screen or mirror, where the image is being reflected, because this is the plane to which the eyes are focusing. The Computer Eyestrain Theory makes a clear break with this traditional thinking by teaching that it is not the focusing distance that is the most important factor, but rather the distance the light carrying the image travels from the light source to the viewer's eyes. The invention is the best implementation of the inventor's theory. However, the invention is not limited by the Computer Eyestrain Theory, and the invention does also provide the added eyestrain benefit of allowing the computer user to comfortably increase the focusing distance while having a larger computer image size.

An eye doctor, Dr. Cosmo Salibello, made public studies that reinforce the Computer Eyestrain Theory by experimenting with different ways to understand the behavior of the visual system. Dr. Salibello invented the concept of PRIO examination on the premise that the principal cause of eyestrain is due to the inherent mechanism by which computer monitors display information - the fact that characters created by CRT's and the like tend to appear to the eye to be closer than they actually are, resulting in the eye cycling back and forth from a "resting point of accommodation" (RPA) (the point at which the eye focuses naturally) to the apparent focus point of the screen. The so-called "PRIO glasses" now available are prescription eyeglasses which cause the RPA to coincide with the surface of the CRT. The PRIO method is set forth in Salibello et al U.S. Patent 4,998,820, "Instrument and Method for use in Optometric Examinations." The importance of the PRIO method is that it firmly establishes with the Computer Eyestrain Theory that eyestrain is not principally generated by radiation, office lighting or other factors but rather by inherent mechanism of direct transmission computer displays.

According to the PRIO line of thinking, it is the low frequency content of the pixels of the image, resulting in poorer contrast and lack of sharpness that cause eyestrain. This does not explain the present inventor's observation that individuals experience little or no eyestrain using a projector at a lower resolution, but experience eyestrain while using a higher resolution CRT monitor. Dr. Salibello made the contribution of describing the behavior of our visual system under computer stress. However, instead of developing a solution that addresses the inherent mechanism of most computer displays - the root cause

of the problem – Dr. Salibello developed a less desirable solution, namely eyeglasses having a prescription optimized for viewing a computer monitor. Certain undesirable aspects of this approach to the computer eyestrain problem are discussed below.

Besides Dr. Salibello's, four other patents have features that support the Computer Eyestrain Theory, although their inventors did not recognize the fact. The following inventions use at least one mirror to reflect the optical path of a conventional CRT image in an eyestrain-reducing system: Tichenor,"Easy Viewing Device with Shielding", U.S. Patent No. 4,930,884, Payner, "Vision Saver for Computer Monitor", U.S. Patent No. 5,200,859, Katz, "Computer Terminal Operators Protection Device", U.S. Patent No. 5,136,434, and Jolly, "Cathode Ray Tube Screen Viewing Aid", U.S. Patent 4,605,291. In each of these cases, the inventor did not attempt to explore projection systems as an eyestrain-reducing system. Each inventor believed that eyestrain was primarily caused by one or more of the following factors: radiation; glare; eyes looking straight ahead at a near distance; eyes looking above the horizontal monitor; or the amount of eye convergence required between looking at the monitor and the keyboard. However, according to the Computer Eyestrain Theory, the common denominator across all these eyestrain reducing systems is the principle of directly transmitted light versus reflected light.

The Computer Eyestrain Theory accommodates for the fact that most people do not experience eyestrain watching TV, a CRT display technology. Most people watch TV from a distance that is much further away than the distance of most computer users from their monitor. People in the majority do not watch TV for 8 to 10 hours a day. Typically computer users experience eyestrain after working 1/2 to 3 hours. The level of stress attributed to watching TV versus working on a computer is very different. The level of stress and duration of work pushes the visual system closer to the threshold of exhibiting symptoms of eyestrain. The additional strain of using a direct transmission display causes 50 percent of computer users worldwide to experience eyestrain, according to the National Institute of Occupational Safety and Health (NIOSH). Rom, ed.., *op. cit.*

Referring to other types of computer monitor which also cause eyestrain, an LCD monitor's principal components are a uniform backplane light source and an active matrix

liquid crystal panel. Polarized light emitted from the backplane of the LCD travels through multiple layers of the liquid crystal panel. Depending on the polarization of the liquid crystal material, the traveling light will either pass (on) or not pass (off) the panel. An active matrix divides the liquid crystal material into cells. A thin film transistor (TFT) independently determines the voltage applied to each cell, and this voltage determines the state of polarization and hence whether light is transmitted through the cell. Therefore, each cell in the matrix has to change polarization state fast enough to produce an image at a rate of 60Hz. A fundamental aspect of the LCD technology is the direct transmission of the image from the light source through the liquid crystal material to the user, the principal cause of eyestrain and headaches.

Three emerging display technologies, referred to as Plasma Display Panel (PDP), Plasma Addressed Liquid Crystal Displays (PALCD), and Field Emission Displays (FED) are not currently available on the market for the desktop monitor application but could be a future alternative to CRT's. All three technologies are direct transmission systems, and therefore each will demonstrate the same health issues, such as headaches and eyestrain.
Image size and resolution are the main parameters of interest in the computer monitor market; that is, consumers attach value to larger image sizes and higher-resolution displays. By comparison, in the TV market, where resolution is fixed by the existing television signal format, it is image size and not resolution to which consumers attach real value. Consequently, big screen televisions can command a higher price because they provide a large image size. Both smaller CRT televisions measuring up to roughly 36 inches diagonal and big screen projection televisions measuring 32 inches and above are capable of display resolutions above 600 lines, but the signal does not provide this degree of resolution. For example, conventional analog broadcasts only offer 240 lines of resolution measured in horizontal lines, while digital satellite systems offer up to 480 lines. Therefore, the consumer mindset in the TV market is that image size primarily differentiates value. Similarly, in the monitor market, the 13" monitors of several years ago have given way to 17" monitors as a standard size, and larger monitors are available. A monitor display technology that could best leverage the projection technology to produce cost effective large images would have an advantage.

One of the most significant characteristics of a CRT monitor is that the diagonal width of the screen is proportional to the monitor depth, making CRT monitors relatively large and heavy. The cause is attributed to the difficulty of directing the electron beam generated by the gun precisely at each phosphor element as the screen gets larger. The solution is to move the gun physically further away from the screen increasing the depth of the monitor, as well as the size of the heavy tube. Popular monitor sizes (measured diagonally) with respective weights are 15 inch weighing 31 lbs, 17 inch weighing 41 lbs, 19 inch weighing 55 lbs, 21 inch weighing 68 lbs, and 24 inch weighing 90 lbs. More particularly, such computer monitors are roughly cubical in overall shape; that is, a monitor having a screen measuring 15 inches diagonally will have comparable measurements for its width, height and depth. The depth in particular becomes a problem in the typical small cubicles provided as workspaces for many workers, noting that the worker might want to move further away from a larger screen in order to comfortably view its entirety without excessive shifting of the user's eyes and motion of the user's head.

In addition, as the CRT's screen diagonal measurement increases, the monitor occupies considerably more office desk space. This is a significant factor, as desk space is nearly always at a premium.

As noted, resolution, e.g., as measured in pixels, is a stronger factor in the monitor market than the TV market, introducing another dimension to the value proposition. Stated differently, the difference is that the bottleneck in the TV industry is the information provided and not viewed, while the opposite is true for the monitor industry. This is the reason that we have to scroll our Microsoft Word window to view the typical document. Few people would argue that image size is clearly the first determinant of the value proposition before resolution, for good reasons. As noted, the CRT television technology has been around for decades, ingraining the mindset that bigger is better. Secondly, it doesn't make sense to introduce a new monitor with more resolution but a smaller or equal image size for a desktop monitor application. The consumer doesn't want to squeeze his or her eyes to see the fine details. The available technology can display different resolutions for a defined image size. In effect, the smaller resolution appears as a "zoom in" of the higher resolution. There are no current or emerging personal monitor

technologies that can cost effectively increase substantially the image size measured in terms of the diagonal length of the screen.

Finally, there are a few products available to help people with eyestrain occasioned by viewing computer monitors. This is a small market in dollar value but growing especially in customer base with far reaching implications. It has been recognized in the market that there is money to be made selling effective solutions for eyestrain. Different companies have attempted to introduce different solutions to the market in the shape of antiglare filter screens, air oxidizers, and computer glasses.

More particularly, several companies are marketing computer filter screens as a solution to computer users experiencing eyestrain. Situated between the monitor screen and the viewer, these filter screens effectively prevent glare and reflections. To a certain degree, they improve clarity and contrast, sharpen character resolution and reduce radiation. The real question is whether screen filters provide an effective solution towards headaches and eyestrain? It is generally accepted that glare and reflection contribute to eyestrain. The extent of that contribution is debatable. However, the present inventor, having experimented with filter screens extensively from one hour to eight hours at a time, has found them in general of comparatively little help dealing with computer health issues, and in particular has found them of little or no use in alleviating eyestrain occasioned by long hours working at a direct transmission CRT. By comparison, the inventor has found eyestrain significantly reduced when applying the principles of the Computer Eyestrain Theory.

Datavision and Devices, Image One, GlareGuard and Magnotech are all companies that market filter screens as a solution to headaches and eyestrain. In addition some of these companies also market their monitor filters as anti-radiation screens attempting to make a connection with monitor radiation and eyestrain.

PRIO Corporation, of Lake Oswego, Oregon (formerly Applied Vision Concepts) has arguably the best solution available on the current market for eyestrain occasioned by the use of computers. Noting, the current invention is not yet on the market, and there is no

real alternative to the PRIO solution for eyestrain. As discussed above, PRIO's solution is based on eyeglasses having prescriptions optimized for viewing computer monitors. PRIO sells eye examination equipment to eye doctors designed to simulate computer use. Based on the PRIO examination, the eye doctor can prescribe computer glasses, that is, eyeglasses comprising conventional lenses and frames but implementing a prescription optimized for viewing a CRT. The disadvantages of PRIO glasses are several. As the PRIO glasses are only useful for viewing the screen, each time the user looks away from their computer he or she must remove or change glasses. Individuals that wear prescription contacts have to wear the PRIO computer glasses over their contacts each time they are in front of a computer system, defeating the purpose of having contacts. Despite these shortcomings, in little over 4 years PRIO has rented their testing equipment to 700 eye doctors nationwide. An eye physician would not rent the PRIO examination package unless a good percentage of his or her patients suffer from eyestrain. Therefore, PRIO has impacted thousand of users reinforcing their understanding of this eyestrain problem. Dr. Salibello did make the contribution of accurately describing the visual system under computer stress.

As noted above, computer monitors take up a large amount of valuable desk space. Recognizing this, there are a large number of patents for monitor support mechanisms, for example U.S. Patent 4,844,387, "Monitor arm apparatus". None of these patents suggest using the arms to support a projector in a personal display application; the relevance of this observation will be made apparent below.

There are video projectors currently on the market that can accept computer VGA, SVGA or XGA input, which are designed for projecting relatively large images for groups of people. Such projectors are available from Sony, In-Focus Systems, Polaroid, and others, and in recent years have become almost universal for "slide talk" presentations using software such as Microsoft's PowerPoint, essentially replacing the older overhead projector and foils with an electronic equivalent. Video projectors have not, however, been used in a projection monitor system application, without complicated fixed arrangements of beam-splitters, mirrors, and so on.

McNelley and Machtig U.S. Patent 5,639,151 for "Pass-Through Reflective Display" recognizes the problems inherent in the use of CRTs, and the bulkiness of larger displays and the eyestrain requirement of longer viewing or focusing distances needed to use larger displays. This patent discloses a is a desktop monitor system using a fixed position projector projecting a video image onto a horizontal screen. An angled beam-splitter reflects the image towards the viewer. This is done to allow a camera to be placed directly behind the beamsplitter in line with the viewer, so that when the display is used for video teleconferencing, the viewer can appear to maintain eye contact with the image of the sender on the screen. The image size is not adjustable beyond the limited and connected screen. In addition, the mirrors and projector housing take up significant amounts of desktop.

Fergason U.S. Patent 5,629,806 for "Retro-reflector Based Private Viewing System" uses a similar arrangement of beamsplitter and screen, plus another screen and mirror, to limit the viewing angle of the resulting display for privacy purposes. Again, the image size is not adjustable beyond the limited and connected screen.

Gale et al U.S. Patent 5,692,820 for "Projection Monitor" discloses a large-screen monitor comprising a lamp, and a light modulator to produce an image that is projected onto a rear-projection screen. A mirror inside the device reflects the light emitted from the lamp at least once before reaching the screen, and the light has traveled a longer distance before reaching the user. The inventors were positioning this display primarily in terms of the technological advantages of producing a larger computer screen in a smaller package, e.g., suitable for desktop use. It is clear that they were not attempting to invent an eyestrain-reducing system, beyond realizing that their projection display inherently does not produce any electromagnetic radiation. Although the inventors did not recognize the fact, this invention does conform to the design principles taught by the Computer Eyestrain Theory. The image size is not adjustable beyond the limited and connected screen, and the unit would take up significant desk space if it were used as such.

Projectors have been used in a number of vehicle systems to provide electronic dashboards or "head up display" systems. Typical of this application is Iino, U.S. Patent 4,967,191, "Display Apparatus for Automotive Vehicle". In these applications, the intention is not a

desktop display for a computer, the image size is not adjustable beyond the limited screen, and the arrangement of parts is specific to the vehicular application, which is not analogous to the desktop display environment.

SUMMARY OF THE INVENTION

According to the invention, a new computer projection monitor system of the invention is provided, termed a "Desktop Projector". The projection monitor of the invention has two main implementations, a basic system and a basic system with an adjustable arm. In the basic system implementation, the projection and reflective screen are used in combination with a personal workspace as a method and system of creating a projection monitor. With the adjustable arm implementation, the projector, reflective screen and adjustable arm are used in combination with a personal workspace as another method and system of creating a projection monitor. According to the basic system implementation of the invention, a method of creating a projection monitor for use in combination with a personal workspace, permitting an operator to view a computer image in a spatially confined area, comprising the steps of: arranging a personal workspace having a first operator location and spatially confined area; positioning a projector having at least one video input for accepting a display signal from a connected computer, capable of creating a projected computer image based on the display signal, within the personal workspace and in proximity to the first operator location; directing the projector to project a computer image away from the first operator location towards the reflective screen within the personal workspace; and reflecting the computer image from the reflective screen towards the first operator location. This method of creating a projection monitor will enable creating a cost effective large computer image, and the ability to vary the image size, especially increase the size.

The projection monitor of the invention is designed for use with personal workspaces. A personal workspace is defined as having a first location for an operator. From the first location, an operator has convenient control access to the computer system including either the computer or the Desktop Projector. A typical computer system could be composed of a computer, Desktop Projector, and a keyboard. The personal workspace

does have a spatially confined area, with a minimum delimitation created by the reflective screen. The screen is positioned or designed to provide a reflective surface towards the first location.

The basic system implementation of the invention integrates the following components into the personal workspace: a projector; and a reflective screen. The projector in this application is basically a display engine with plastic enclosure, controls and user interface to form the finished product. The screen can be hung on a wall, from a ceiling, or stand upright on an office desk or floor, or could be the wall itself or a coating on the wall.

According to the adjustable arm implementation of the invention, a method of creating a projection monitor for use in combination with a personal workspace, permitting an operator to view a computer image in a spatially confined area, comprising the steps of: arranging a personal workspace having a first operator location and a spatially confined area; connecting an adjustable arm to a planar work surface within the personal workspace in proximity to the first operator location; mounting a projector having at least one video input for accepting a display signal from a connected computer, capable of creating a projected computer image based on the display signal, within the personal workspace onto the adjustable arm; directing the projector to project a computer image on the adjustable arm and away from the first operator location towards the reflective screen within the personal workspace; and reflecting the computer image from a reflective screen towards the first operator location. Beyond the basic system, the adjustable arm implementation provides additional flexibility in creating a large image size, at a desired closer distance, and a larger degree of freedom in increasing the image size of the monitor.

The adjustable arm enables the user conveniently to adjust the distance from the screen to the projector, while providing a secure support for the projector and minimizing the need for monitor desk space. Furthermore, supporting the projector on arm allows the projector to be spaced further from the screen than permitted by the depth of the desk, which can be important in providing sufficient spacing to allow focusing. The arm can preferably rotate a full circle either at the vertical cylinder or at the resting plate. This flexibility allows the projector to face the screen at the correct angle for various distances at any clamping

position on the office desk. The advantage of providing variable distance functionality is greater choice of image sizes. The actual image size provided by this monitor depends on the focal length of the lens and the distance to the screen, from as little as 10 inches (measured diagonally) to 30 to 50 inches, depending on the space available.

An aspect of this invention, a method of operating a computer system in a personal workspace, permitting an operator to view a computer image in a spatially confined area, in such a manner as to reduce eyestrain comprising the steps of: transmitting a display signal from a computer to a projector, having at least one video input for accepting a display signal from a connected computer, capable of creating a projected computer image based on the display signal, with the projector positioned in proximity to an operator in the personal workspace having a first operator location, with at least operational access to the computer, and a spatially confined area, with a minimum delimitation consisting of the reflective screen; projecting the computer image from the projector and away from the operator towards a reflective screen within the personal workspace; and reflecting the computer image from the reflective screen towards the operator at the first operator location. The combined effect of an operator receiving only reflected light of the computer image over a distance, which is greater than the conventional distance of the light path of the computer image from a directly transmitting monitor to an operator, is to reduce eyestrain, while providing the ability for operator to create larger image sizes also helping to reduce eyestrain. This method of operating a computer system does not produce any electromagnetic radiation, which may also contribute to eyestrain.

Another aspect of the invention, a method of operating a computer system in a personal workspace, permitting an operator to view a computer image in a spatially confined area, in such a manner as to reduce eyestrain comprising the steps of: transmitting a display signal from a computer to a projector, having at least one video input for accepting a display signal from a connected computer, capable of creating a projected computer image based on the display signal, mounted on an adjustable arm connected to a planar work surface, with the adjustable arm positioned in proximity to an operator in the personal workspace having a first operator location, with at least operational access to the computer, and a spatially confined area, with a minimum delimitation consisting of the

reflective screen; projecting the computer image from the projector on an adjustable arm and away from the operator towards a reflective screen within the personal workspace; and reflecting the computer image from the reflective screen to the operator at the first operator location. The combined effect of an operator receiving only reflected light of the computer image over a distance, which is greater than the conventional distance of the light path of the computer image from a directly transmitting monitor to an operator, is to reduce eyestrain. The additional combined effect of the adjustable arm enhancing the ability for the operator to create larger image sizes, at a desired closer distance, while further increasing the light path distance of the computer image for a given size, is to also reduce eyestrain. This method of operating a computer system does not produce any electromagnetic radiation, which may contribute to eyestrain.

Another aspect of the invention, a projection monitor system for use in combination with a personal workspace, in which the system permits an operator to view a computer image in a spatially confined area, the system comprising: a personal workspace having a first operator location and spatially confined area; a projector having at least one video input for accepting a display signal from a connected computer, capable of creating a projected computer image based on the display signal, within the personal workspace, located in proximity to the first operator location, positioned to project a computer image away from the first operator location and towards the reflective screen; and a reflective screen, within the personal workspace, located to receive the computer image from the projector and reflect it towards the first operator location, wherein the path of the light carrying the computer image from the projector to the reflective surface and finally to the operator is greater than a conventional distance from a directly transmitting computer monitor to the operator. The basic system implementation does conform to the design principles of the inventor's Computer Eyestrain Theory.

Another aspect of the invention, a projection monitor system for use in combination with a personal workspace, in which the system permits an operator to view a computer image in a spatially confined area, the system comprising: a personal workspace having a first operator location and a spatially confined area; an adjustable arm connected to the planar work surface within the personal workspace and positioned in proximity to the first

operator location; a projector having at least one video input for accepting a display signal from a connected computer, capable of creating a projected computer image based on the display signal, within the personal workspace located on the adjustable arm to project a computer image away from the first operator location and towards the reflective screen; and a reflective screen within the personal workspace located to receive a computer image from the projector and reflect it towards the first operator location, wherein the path of the light carrying the computer image from the projector, located on the adjustable arm, to the reflective surface and finally to the operator is greater than a conventional distance from a directly transmitting computer monitor to the operator. The adjustable arm system implementation does conform to the design principles of the inventor's Computer Eyestrain Theory.

The Desktop Projector is a new computer monitor technology with inherent superior advantages over all current and emerging personal monitors in the display industry. The invention enables a user defined variable image size, with a new degree of freedom in varying, especially increasing, the image size. In addition, the Desktop Projector is superior to the overwhelmingly established CRT monitor because of its minimal desktop usage and lightweight. The invention is also the most cost competitive projection monitor that will dramatically reduce or potentially eliminate eyestrain, occasioned by the use of a computer, in the world compared to all other current or emerging display technologies.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a schematic plan view showing the projection monitor system of the invention;

Fig. 2 is a schematic plan view showing a typical personal workspace using existing CRT monitor;

Fig. 3 is a view comparable to Fig. 2, showing the same workspace but using the projection monitor system of the invention having the adjustable arm, thus illustrating the space dimension advantages of the invention.

Fig. 4 is a perspective view showing the projection monitor system of the invention in use, in an embodiment having a table-top supported screen and the adjustable arm of Figure 5;

Fig. 5 shows a view of an adjustable arm for use with the invention;

Fig. 6 shows another adjustable arm for use with the invention;

Fig. 7 is a view comparable to Fig. 4, but showing the projection monitor system of the invention in use, in an embodiment having a screen hung on a wall, and an adjustable arm of Figure 8;

Fig. 8 shows another adjustable arm for use with the invention;

Fig. 9 shows another adjustable arm for use with the invention;

Fig. 10 is a top cross-sectional plan view of a typical CRT monitor technology;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Overall Description

Referring to Figure 1, the projection monitor system of the invention, also known as the Desktop Projector, is designed for use with a personal workspace as depicted in this example. The workspace has a first location for the operator or first operator location with the positioning of the chair (106) relative to the screen (105) and projector (101). The projector (101) on the desk (107) is positioned in proximity to the first operator location, and positioned to project a computer image away from the first operator location towards the screen (105). In this configuration, the screen (105) is supported by a tripod (125), and is positioned to receive the computer image and reflect it towards first operator location. The computer (102) is connected to projector (101) and wireless keyboard (104).

The screen (105) with the tripod (125) can be moved or the projector (101) to adjust d_3 the distance between the projector and screen. The larger the distance d_3, the larger the

computer image size W is at the screen (105). Approximating the projector (101) as the light source, the light carrying the image travels from the projector (101) to the screen (105), a distance d_3. The light experiences reflection at the screen then travels a distance d_2 to the operator (110) positioned on the chair (106).

As for the other personal projection systems such as Gales' "Projection Monitor" with U.S. Patent 5,692,820, McNelley's "Pass-Through Reflective Display" with U.S. Patent 5,639,151 and Fergason's "Retro-reflector Based Private Viewing System" with U.S. Patent 5,629,806 each of these personal projection systems do not have the capability to increase the image size to the same degree of freedom as the Desktop Projector.

Figure 7 shows a different configuration of the projection monitor system of the invention, with the flat screen (5) being hung from the wall by hangers (40). The projector (1) positioned on the adjustable arm (8) projects a computer image away from first operator location and towards the reflective screen (5). The reflective screen (5) is positioned to receive the computer image and reflect it towards the first operator location. Figure 7 also shows a variation on the mounting of the projector support, in which the adjustable arm system (8) is mounted to the desktop with a vacuum base (41), which allows easy mounting and removal, and simple adjustment of the projector position across the desktop, as shown in this configuration. The adjustable arm provides a greater ability to vary the distance between the projector and the reflective screen, enhancing the range of computer image sizes available in the personal workspace.

Figures 2 and 3 illustrate space dimension advantages of the Desktop Projector installed in a similar workspace as a CRT monitor. Consequently, the projection monitor system of the invention provides a larger monitor, where the user is spaced further from the monitor, than if using a conventional CRT computer monitor. Figure 2 shows a plan view of a typical workspace with a CRT, and Figure 3 a comparable view using the projection monitor system of the invention. Thus, in Figure 2, the workspace has a screen (105b), transparent glass screen part of the monitor (112), directed and designed to send the image to a first location, the chair (106), for an operator (110). The computer (102) is connected

to the keyboard (104). Into this space users typically desire to have the largest possible desk (107), since desktop space is at a premium, with a chair (106).

Referring to Figure 3, d_3 is an integral monitor design parameter for the adaptable Desktop Projector, which is beyond the customizable design parameters for the rigid CRT. Figure 10 depicts a top cross sectional view of a CRT monitor (112), further illustrating the distance between the closest part of the imaging device (202) and the screen (203) is d'_3. The screen in a CRT and all other non-projection display systems is composed of a transparent screen, commonly type of glass material. The internal imaging device in non-projection display system is fixed relative to the transparent screen of the display. Referring to Figure 10, the electron gun (204) enclosed in the CRT tube (201) with the wall of phosphor elements (202) delimits the imaging device. The imaging device (201) is physically fixed in position relative to the transparent glass screen (203) of the CRT. Comparing to other personal projection systems, the internal imaging device is either fixed or has very limited variability to increase the distance relative to the screen. The limitation is inherent in most system designs because the imaging device, or projection system component, is connected to the screen encasement or support structure. The limitation is also inherent because imaging device has to function within the limitation of the screen.

In an analogy to the Desktop Projector, the imaging device is the projector and the distance between the screen and the projector is a function of the specific and relative location of the projector and much larger screens within the personal workspace, providing a new degree of freedom in varying the image size. This distance is an integral monitor design parameter of the invention with important implications for the screen size and adherence to the design principles of the Computer Eyestrain Theory.

As noted in Figure 2, a typical computer monitor is roughly cubical, so that a monitor (112) having a diagonal screen measurement of M will be approximately M deep; stated differently, the display screen of a conventional monitors (112) must be spaced a considerable distance (comparable to the diagonal measurement of the screen by which such monitors are usually selected) from the edge of the wall (150), which in turn limits

the viewing distance between the operator (110) and the screen of monitor (105b) to a short distance d_1. Moreover, as noted, in this arrangement the user experiences direct transmission of the light from the screen to the eye over a short distance, which, according to the inventor's Computer Eyestrain Theory principally contributes to eyestrain. Workspace of Figure 2 has a desk (107) and, of course, the monitor (112) takes up a substantial amount of valuable desktop real estate.

Figure 3 shows the projection monitor system of the invention in a comparable workspace. Instead of monitor (112), the operator is provided with the Desktop Projector consisting of a projector (101) mounted on an adjustable arm (108), and projecting a computer image away from the operator (110). The computer (102) is connected both to the projector (101) and keyboard (104). The projector (101) is positioned by the adjustable arm (108) in proximity to the first operator location (106) to create an image of width W at the location determined. Screen (105) positioned to receive the computer image and reflect it towards the operator (110). There is a first location, the chair (106), for the operator to receive the reflected computer image from the screen (105). As screen (105) is essentially flat, and may even be wall (150), if suitably smooth and light-colored, it consumes no space. As illustrated in Figure 3, an image of width W can thus be provided in a given space that is much larger than M, the largest image possible using a standard monitor. Hence the viewing distance d_2 between the screen (105) and operator (110) is at least greater than d_1 by M, the image now travels a longer distance d_2 than previously to the operator's eyes.

In accordance with the design principles of the inventor's theory, the Desktop Projector is designed to produce a longer path from the projector (101) to the operator (110) for the image to travel within the personal workspace. This is mainly accomplished by the location of the projector and screen. The positioning of these components is influenced by a desire to create a larger image size of width W in the space illustrated. At the same time, depending on the application of the invention, it is preferred that Desktop Projector be connected to the desk (107), via an adjustable arm like (108), and that the screen (105) be adjacent or close to the desk (107), while maximizing the distance. In this manner, it is difficult for the user to inadvertently get in the way of the projected image, with physical

movements. Providing an image of width W in the space illustrated using a conventional monitor would be out of the question, as the monitor required would be so large that the operator's eyes would be but a few inches from the screen, making it impossible to see the entire image.

The invention allows a relatively large image to be provided to the operator of the computer in a relatively small space. For example, the projector can be located other than directly in front of the operator, as is necessary in use of a CRT, and the screen can be spaced some distance away. In a typical direct replacement of a CRT by the projection monitor system of the invention, the overall distance between the reflective screen and the operator could be approximately double the length between the CRT and the operator, depending on the exact location of the operator. Because the reflective screen is essentially flat, the distance between the operator and the reflective screen is greater than the distance between the operator and the CRT by at least the depth of the CRT. Therefore, the computer user can comfortably view the monitor without feeling the need to move further away to avoid the shifting of the eyes or head, while creating an advantage in image size and distance, from a vision acuity prospective.

According to the invention, d_3, the distance from the projector (101) to the screen (105), is equal to the sum of d_L, the depth of the desk (107), and d_a, the effective length of the support arm. The adjustable arm enhances the Desktop Projector's ability to provide greater customization of the image size, at the operator's discretion. In relatively small workspaces where focusing is an issue, arm system allows focusing of the projected image on the screen by further increasing the distance, d_3.

According to the invention, as in Figure 3, the overall distance from the light source, approximated by the projector (101), to the viewer includes not only d_2 but also d_3, the distance image travels between the light source and the user's eyes is the sum of d_2 and d_3, a much longer distance traveled than in Figure 2 between light source and the user's eyes. In Figure 2, the light sources of the CRT monitor are the phosphor elements near the front glass of the monitor. The computer image from the projector undergoes reflection at screen (105) having a width sized W. Finally, in accordance with the inventor's Computer

Eyestrain Theory, the light carrying the image travels a longer distance and experiences reflection in the path between the light source and the user's eyes principally reducing eyestrain. A larger image size W, at a comfortable distance of d_2, will also reduce eyestrain.

In the embodiment shown in Figure 4, the adjustable arm is attached to a computer user's desk (7) by a clamp (9) or other attachment means such as a screwed-down mounting plate (for a permanent installation), or the like. The projector tray (8) supports the projector (1) off the desktop (7), to give the maximum desk space for the user (6). The projector tray may be moved on the adjustable support structure over a wide range of positions and angles. The projector (1) is connected to the user's computer (2) by conventional cables (3). The user places her keyboard (4) on the desktop or on a keyboard tray, as is conventional. The screen (5) is located near the back of the desk (7), to allow maximum distance from the projector (1), and may, in fact, be hung on the rear wall of a cubicle or office. If suitably smooth and light-colored, the wall itself may be used as the screen, which is the ultimate "flat display", providing an even greater degree of freedom in varying the image size.

Thus, using the system as shown in Figure 4, the user views her computer's display as light reflected from a screen that has traveled a longer distance from the light source, rather than by direct transmission as is the case with monitors of the CRT, LCD, plasma and other types. By the Computer Eyestrain Theory set forth above, this dramatically reduces the eyestrain involved in using the display over the direct transmission systems. In all projection systems, there is no electromagnetic radiation – an inherent advantage. Electromagnetic radiation may be a contributing factor to eyestrain.

According to the invention, the viewed image is produced using a projection system, where the core technology is on a display chip. The display size can be varied easily and over a wide range of sizes by moving the projector towards or away from the screen, and by the built-in zoom lens of the projector, if it is so equipped, while the actual image as provided by the computer does not change. Therefore, the core technology for a projection system does not have to grow in proportion with a larger display, lowering

material costs and taking greater advantage of the highly developed semiconductor chip manufacturing momentum compared to other non-projection personal display technologies including.

If the screen is large, or the wall itself is used, the position of the display may also be easily changed by swiveling the projector on its adjustable support structure. The display brightness and focus are also adjustable using the projector's controls.

The Projector

The projection monitor system of the invention does not require any specific projector type. Small projectors are preferred. Various suitable projectors are readily available, and are quickly evolving in price and quality as the technology improves. The three-CRT projectors of a decade ago have been supplanted by LCD-based projectors capable of much higher resolution with a much smaller footprint and no complicated and time-consuming convergence procedures. The 640 by 480 pixel resolution VGA projectors of recent years ago are far surpassed by today's 800 by 600 pixel SVGA projectors, which cost considerably less. Any of these technologies, or others which might be developed in the future, would be appropriate for use with the invention.

For example, the InFocus LP225, manufactured by InFocus Systems, Inc. of Wilsonville, Oregon, is a true 800 x 600 (SVGA) resolution projector capable of 16.7 million colors. With compression, the LP225 can handle 1024 x 768 (XGA) images.

A complete projector basically consists of an imaging system with associated drive circuitry, a complementary optical lens system, and a light source. In recent years, each component technology has made real progress to make the projection technology a viable alternative for personal displays. The lens technology has not changed dramatically in terms of affecting engine performance as compared to the other components, but automatic zoom and power focus lenses are becoming more common than the fixed focal length, manual-focus lenses of the recent past.

With today's computer standards, a projector for use with the projection monitor system of the invention will have the capability of projecting at least standard VGA resolution (640 by 480 pixels), and preferably SVGA or XVGA resolution of 800 by 600 pixels or greater. It can be expected that as time goes on even higher resolutions will become standard. Additional input formats, such as NTSC/PAL video, would be advantageous if other video sources such as videotape were to be used.

A zoom lens is preferred, but not essential, to allow the size of the image to be easily changed without physically moving the projector. If a fixed-focal-length lens is used, it should be of such a focal length as to be able to display a screen image of reasonable size (e.g., 19" - 24" diagonal) at a projector to screen distance of not much more than the depth of an average desk (two to three feet).

Also preferred in a projector is an adjustment for horizontal and vertical "keystoning", or distortion of the display caused by the projector not being exactly aligned with the screen. Obviously, it would be awkward to move the projector on its support arm directly in front of theoperator. With keystoning adjustment, the projector can be off to one side, and above or below the screen, as shown in Figure 4, and the display will be undistorted. This can be done either by distorting the image on the LCD or CRT or light modulator (miniature imaging device) internal to the projector, or by physically angling the LCD or CRT or light modulator with preferably the help of the adjustable arm. Keystoning adjustments are available on many, if not most, of the projectors currently available.

An additional inherent functionality of the Desktop Projector is the ability for the customer to easily remove the projector from the mechanical arm for independent use as a presentation tool in conference rooms for small audiences.

Preferably, the projector chosen for the projection monitor system of the invention will have a user replaceable lamp. This provides a relatively inexpensive solution in prolonging the life of a projection system beyond any other emerging display technology. A user replaceable lamp will speed turnaround in getting a bright projector running again.

Turnaround is faster with a user replaceable lamp because time is not wasted shipping the projector to the shop, and the processing time of the shop is no longer a factor.

A projection system is brighter than a non-projection display system but the real question is how much brighter? In this application, brightness can be defined as the amount of light that reaches a given viewing area or screen. After experimenting with a p-Si LCD projector with a 200 ANSI lumen capacity and comparing it with CRT technology, we have confidence that a state of the art projection system, producing an image 14 to 19 times brighter than the experimental projector, such projectors being expected to be commercially available in the near future, will be brighter than CRT monitor technology.

The Screen

The screen used for the projection monitor system of the invention can be of any convenient design and size consistent with the provision of a display of chosen size. As typical projectors produce noninverted images, conventional diffuse screens (i.e., as opposed to specular mirrored surfaces, which invert the image) are preferred. Preferably, the screen will be at least as large as a conventional monitor - 17" or more on the diagonal, with the standard width-to-height aspect ratio of approximately 1.3:1. A rigid screen is preferred to the roll-up kind commonly used for slide projection, so that the display will be as consistent as possible.

As shown in Figure 4, the screen (5) may be supported by side wings (22), or a rear support structure, or may be clamped to the rear edge of the desk. Alternatively, the screen can be a conventional slide-projector type screen standing on the floor behind the desk, or, as shown in Figure 7, a rigid flat screen hung from the wall or ceiling by any conventional means, such as hooks (40). The screen, including the support structure, is preferred not to be directly connected to either adjustable arm or projector. The surface of the screen can be any of the conventional screen surfaces, such as lenticular or beaded, or could be simply smooth white flat or semi-gloss material.

If the rear wall of the office or cubicle is flat and smooth enough (plaster or plasterboard, as opposed to rough sound-deadening cloth), then the wall itself may be used as a screen. A part of the wall can be painted white, or coated with a high-reflectance white coating such as is used on conventional projection screens.

The Adjustable Arm

Preferably, the projection monitor system of the invention has an adjustable arm system. The preferred arm system is made up of a desk-top, or table-top mount, a projector tray, and a support arm for movably and adjustably supporting the projector tray. In very confined workspaces, the goal in preferring the use of an adjustable arm system, as opposed to simply resting the projector on the desktop, is that this allows the projector to be spaced further from the screen than permitted by the desktop itself, thus enabling a functional display system.. In more spacious personal workspaces, the use of the supporting arm will always enhance display system function by enabling even greater freedom in varying the image size, while minimizing desktop usage. . The adjustable arm system should permit the projector to be supported above the desktop, and should be removable from the table top and capable of attachment at variable predetermined locations on the desk. Provision of height adjustment of the arm system and of the ability of the projector tray to swivel is also preferred but not required. Preferably, there would also be an adjustment for the tray angle with respect to the horizontal, although this can be omitted if the projector has an adjustable front foot, as most do.

Commercially available adjustable monitor supports, such as the model P6143 "Deskit" made by AVF Group, Ltd., of Telford, Shropshire, UK, could be used with the invention, with the monitor support surface serving as the projector support tray. The Sorgi patent, 4,844,387, cited above, shows such a monitor support.

Figures 5, 6, 8 and 9 show a number of different adjustable arm systems, which can be used with the projection monitor system of the invention. The various features of the

supports shown in these figures can also be interchanged among the arm systems, as will be recognized by one skilled in the art.

Referring to Figure 5, this adjustable arm system has a lower portion (9) for attaching the support to the user's desk or table. The lower portion can provide other means of attachment as well, in place of the clamp, such as a flat plate to be permanently fastened to the table top, strong suction mounts, or other arrangements as are known to the art. With this clamp configuration, the bottom end (19) of the lower portion extends at right angles to the vertical portion, and is drilled and tapped to accept a screw (20). The screw (20) pushes on a sliding bar (18), clamping the table top between the bar (18) and a horizontal bar (17) on the support lower structure (9). The bar (18) provides more clamping area for a stronger hold and less chance of marring the underside of the table top. If desired, however, the bar (18) could be omitted, and the screw (20) could be provided with a domed swivel end as is commonly used for C-clamps or the like. Preferably, the screw (20) is fitted with a t-bar (21) or other handle, for ease of tightening and loosening. Alternatively, the end of the screw could have a wing or hex-nut shape, or there could be more than one screw.

At the upper end (11) of the lower portion (9) a lip or collar supports the swivel arm (10), which has a hole which fits over the end of the lower portion (9), allowing the swivel arm (10) to swivel around the lower portion (9). At the other end of the swivel arm (10), another hole fits a shaft (12) extending downward from the projector tray (8). A set-screw (13), fitting in a tapped hole in the end of the swivel arm (10), can be screwed against the shaft (12), holding it in place. The tray (8) can be adjusted to a wide range of projector heights by sliding the shaft (12) in the hole and tightening the set-screw (13). As noted, preferably the shaft (12) is attached to the projector tray (8) through a mechanism which permitting tilt adjustment of the tray (8). In the arm system shown, the end of the shaft (12) is attached by a pin (16) to a U-shaped bracket (14). When the set-screw (14) is loosened, the tray (8) may be tilted on the pin (16) to the desired tilt angle, and then held at that angle by tightening the set-screw (14). Alternatively, the projector tray could be supported on a conventional ball-joint or double-swivel, or other such arrangement

conventionally used on tripod heads or the like, providing an additional degree of adjustment.

Figure 6 shows an alternate adjustable arm system of Figure 5, in which an extension (32) of the lower portion (9) is at an angle to the vertical. The inner end (31) of the swivel arm (10) is formed as a collar, with a set-screw (30), so that it may be moved along the extension (32) to adjust the height and position of the arm (10). The extension (32) may be fixed in position, or, by being formed of a smaller diameter material and fit into the upper end (11) of the lower portion (9), may swivel around to provide more flexibility to the positioning of the projector tray. In the Figure 6 arm system, the projector tray (8) is supported on a ball-joint having a body (37) attached to the swivel arm (10), and a ball (38) within the body, to which the tray (8) is attached by a short post. A set-screw (14) holds the ball (38) in position, but when the set-screw (14) is loosened, the projector tray (8) may be tilted in any direction. Figure 6 also shows an alternative to the clamp base of Figure 5, in which the lower portion (9) of the support is bolted to the work surface using a fixed base (34) into which the lower portion (9) fits. Base (34) has a flange (33) with holes through which bolts (35) may be fit. The work surface is drilled for the bolts (35), and the bolts (35) are fastened down with matching nuts (36)'. Alternatively, wood screws or self-tapping sheet metal screws, or lag bolts, could be used in place of the bolt-and-nut arrangement.

Figure 8 shows an adjustable arm system, in which the projector tray (8) is fixed to a vertical support strut (50). The lower section of the support (9) is clamped to the table edge by a two-part clamp having an upper part (57), which may be slid along the length of the lower section (9) and fixed in place by a set-screw (23), and a lower part (54) which can also be slid along the length of the lower section (9) by depressing a slide clamp lever (55). When the lower part of the clamp has been adjusted close to the bottom of the tabletop, the clamp lever (55) is released, and the clamp screw (56) is tightened to hold the support firmly to the table top. The height of the tray (8) may be varied by sliding strut (50) into the hollow upper section of the support base (12), and locking it in place with a set-screw (51) threaded into a collar (52), tripod leg clamp, or similar element.

Figure 9 shows another adjustable arm system. In this arm system, the support arm (60) for the tray (8) is bent at right angles, so as to provide a single-piece support and horizontal movement arm. The height of the support arm (60) can be adjusted as described in Figure 8, above, by sliding the lower vertical portion of the support arm (60) into the hollow vertical support pipe (62) and locking it in place with a set-screw (51) threaded into a collar (52), tripod leg clamp, or similar element. The vertical shaft of the support arm (60) is attached to the tray (8) with a swivel (61), so that the tray may be swiveled in a horizontal plane to aim the projector as desired. The vertical support pipe (62) forms part of a vacuum base (64) of conventional design. The vacuum base (64) can be moved into a desired position on the desktop, and then a vacuum lever (63) is moved to create a partial vacuum between the vacuum base gasket (65) and the desktop, holding it firmly in place. Vacuum bases of this kind are often used for table-top mounting of vises, lamps, camera supports or circuit-board clamps, but have not previously been used to mount projector supports in the novel projection monitor system of the invention.

The Desktop Projector features inherent design advantages over all current and emerging personal monitors in the display industry. The invention has the following advantages: produces cost effective large image sizes; enables a new degree of freedom in varying the image size, especially increasing the size, while creating a flat monitor; much longer total product lifetime with preferred user-replaceable lamps compared to non-projection displays. In addition, the projection monitor system of the invention is superior to the overwhelmingly established CRT monitor because of its minimal desktop usage and lightweight.

Accordingly, it is to be understood that the embodiments of the invention herein described are merely illustrative of the application of the principles of the invention. Reference herein to details of the illustrated embodiments are not intended to limit the scope of the claims, which themselves recite those features regarded as essential to the invention. I claim:

ABSTRACT

A "Desktop Projector" is a computer projection monitor method and system comprising of a projector, and a reflective screen integrated into a personal workspace providing several benefits. Projection monitor has a configuration of the projector and screen position in a personal workspace, providing the ability to create a large personal computer image and further increase the size. Further comprising an adjustable arm to support the projector, the Desktop Projector enables the user to increase the control of the distance from the screen to the projector, enhancing the range of image sizes created, while providing a secure support for the projector and minimizing the need for monitor desk space. The invention is a methodology and system design of eyestrain reduction for personal displays. The projector in this application is basically a display engine with plastic enclosure, controls and user interface to form the finished product. The screen can be hung on a wall or from a ceiling or stand upright on an office desk, or could be the wall itself or a coating on the wall.